

## 32. Contributions to the Anatomy of the Ophidia.

By JOSEPH C. THOMPSON, Surgeon, United States Navy\*.

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(Text-figures 77 &amp; 78.)

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*Suggestion as to the Possible Origin of the so-called  
Tracheal Lung.*

It is suggested that the tracheal membrane has been developed as a device originally contributing to the required flexibility of the tube. The cartilaginous rings being interrupted behind, or on one side, permit that the structure be subject to a much greater pressure, especially when bulky morsels are being swallowed, than would be the case were the rings complete. The tracheal membrane, being continuous with the lung, appears to have afforded a convenient foundation for the extension of pulmonary tissue when the need for an increased breathing surface has arisen, or when the lung has been encroached upon by other organs.

In the Hydrophidæ an increased pulmonary area is required both to give buoyancy and to enable the sea-snakes to remain some time beneath the surface. The most specialized species in the genus *Hydrophis* Daudin, those in the *fasciatus* group, possess a lung that extends nearly to the vent, and a tracheal lung of due proportion.

In the Acrochordinæ, the members of which are of aquatic habits, there is also a highly developed tracheal lung. Owing to the abnormal size of the heart the respiratory tissue on the trachea is widely separated from the lung itself.

In the Viperidæ the elaboration of venom requires a large liver. These serpents as a rule have short and thick bodies, and the liver invades the region just caudad of the heart. As a

\* Communicated by Dr. F. E. BEDDARD, M.A., F.R.S., F.Z.S.

result of this the crowded pulmonary tissue seeks the direction of least resistance, which is along the tracheal membrane.

In recording the position of the viscera it has been found advantageous to adopt the following routine with the view of correlating the data obtained. The serial number of the gastrosteges that underlies the anterior tip or the posterior extremity of an organ is taken as the external landmark. This number is reduced to a percentage, the total number of the ventral shields in the specimen being used as the base. From this procedure there results a set of figures which will materially aid in comparing one species with another or in learning the extent of the variation which the individuals of a given form exhibit.

It appears that whenever a serpent varies widely in an important character from one of the natural groups, a further investigation regularly results in the finding of several additional structural features that are well worth making a matter of record. The single species constituting the family of Xenopeltidae may be taken as an illustration of this general statement.

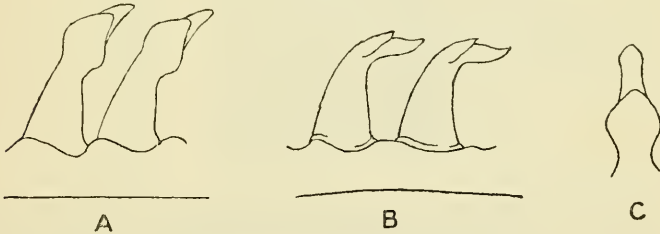
*Some Notes upon Anatomy.*

XENOPELTIS UNICOLOR Reinhardt. (Text-figs. 77 & 78.)

*Specimen.* No. 16750, California Acad. Sci. Singapore. Female; total length 480, tail 58 mm.

*Squamation.*—Scales in 15 rows anteriorly, and the same posteriorly, an oblique series commencing at one gastrosteges

Text-fig. 77.



Teeth of *Xenopeltis unicolor*.

- A. Maxillary bone viewed at a right angle to the outer edge, and showing the oblique fashion in which each tooth is set in the jaw.  
 B. Profile view of the same teeth, showing the lateral cutting-edges of the cusp.  
 C. Palatine tooth viewed from below, and showing a stout and blunt tip which exhibits a tendency to assume the arrow-head shape of the cusps.

terminates at the ninth ventral shield to the rear. Gastrosteges 177. Anal divided. Urosteges 32 pairs, the second entire. Loreal and præocular absent. Postoculars 2. Anterior temporals 2, posterior 3. Supralabials 8, the fourth and fifth entering the eye. Infralabials 9.

*Anatomy.*—There are two dental characters in this species that are unparallelled among the Ophidia. The most striking is the shape of the individual tooth, and the fact that the teeth borne on the palatine bone are decidedly the largest. Each tooth is set in the alveolar ridge with the anterior surface directed forward and outward at an angle of  $45^{\circ}$  with the long axis of the bone. When a tooth is viewed from the anterior surface, it appears a trifle constricted at the middle; towards the extremity it flares out laterally, and terminates like a blunt spear-head, with two cutting-edges that meet at a right angle. When viewed from the side, this anterior cutting-edge is seen as a narrow, beveled cusp, and from its base the tooth is continued backwards as a horizontal process, the length of which is equal to the broad diameter of the tooth. The edges of the cusp and the tip of the backward—directed point are covered with brownish enamel.

The hypapophyses are present on the anterior vertebræ and absent on the posterior. They have a moderately long base.

In the writings of Cope\* this form is credited with possessing a coronoid bone. By Mr. Boulenger, however, it is placed in the category of those in which this structure is absent. Two specimens have been examined and no vestige of the bone can be found.

The external landmarks of the principal viscera in terms of gastrosteges are as follows:—

Total number of gastrosteges.....	177	100 p. cent.
Apex of heart .....	52	29.4
Liver, anterior tip .....	64	35.1
„ posterior end .....	116	65.3
Gall-bladder, middle .....	129	73
Kidney, right, anterior tip .....	146	82.5
„ „ posterior end ...	155	
„ left, anterior tip .....	150	85
„ „ posterior end ...	161	
Ileo-cæcal valve .....	157	88.8

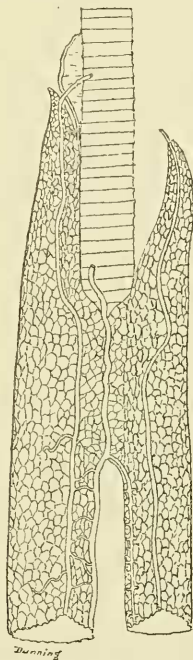
The heart is large, and its position is indicated on the thoracic walls by a distinct bulging. Over the base of the organ there are two areas in which the scales are enlarged; each area is triangular, with the base along the edge of the ventrals and the apex at the upper border of the fourth row. In the first row are five scales, each of which is one-third larger than those before or behind the heart. The scales in the seven dorsal rows are not altered. The increase in the diameter of the body over the heart is compensated for by an increase in the size of the scales in the outer rows, and not by the interpolation of an additional series.

The tracheal rings are complete from the glottis to the ninth gastrostege. From this point the rings are interrupted, and the

\* *Croc., Liz. & Sn. N. Amer* 900, p. 731.

dorsal wall of the trachea is formed by the tracheal membrane which joins the ends of the incomplete rings. From the 9th to the 21st gastrostege the ends of the rings are in contact and the membrane lies collapsed above them. From this point to the base of the heart, the membrane widens and the ends of the rings are permanently separated. Dorsal to the heart the tracheal membrane winds around to the right side of

Text-fig. 78.

Base of the lungs of *Xenopeltis unicolor*.

Viewed from below; the object being to display the bridge uniting the two lungs, the termination of the trachea, the long free apex of the left lung, the adherent apex of the right lung, with its tiny free tip, and anterior to it the portion of the tracheal membrane which is lined internally with pulmonary tissue and is bordered by a branch of the pulmonary artery.

the tube, and 2.5 mm. before the trachea enters the lung it becomes lined with pulmonary tissue. The two lungs are adherent for a distance of 10 mm., the connecting bridge extending from the 53rd to the 57th gastrostege. Viewed from within, this bridge appears as a septum lined with alveoli and

dividing one lung from the other. There are two perforations affording communication between the lungs; the larger, measuring 2 mm. in diameter, is at the termination of the trachea, and the smaller, measuring 1 mm. in diameter, is near the posterior border of the septum. The trachea ends abruptly 3 mm. behind the apex of the heart, and on the lower surface of the bridge.

The right lung extends from the 49th to the 119th gastrostege. Anteriorly, it reaches 8 mm. beyond the border of the bridge; it is adherent to the right side of the trachea for the distance of 6 mm., and has a free apex 2 mm. long. The trachea communicates with the lung 2.5 mm. behind the point where they join.

The left lung extends from the 50th to the 77th gastrostege. Anteriorly it terminates in an acutely pointed free apex 8 mm. long, at the level of the auriculo-ventricular septum. Posteriorly the lung terminates in a blunt cone, and towards the end the walls are a trifle thinner and the alveoli larger. There are two pulmonary veins. The right courses along the angular ventral border of the right lung and enters the anterior inferior corner of the auricle. The left commences at the posterior border of the bridge and enters the posterior inferior corner of the auricle. This vein is the thicker of the two. It is formed of two branches that arise along the mesial side of each lung; the branch from the right lung is the larger, and it has frequent anastomoses with the right pulmonary vein.

The liver extends from the 64th to the 116th gastrostege. There is no trace of segmentation.

The centre of the gall-bladder is at the 129th gastrostege.

The right kidney extends from the 146th to the 155th, and the left from the 150th to the 161st gastrostege. Each is semidivided into nine irregular lobes. The right kidney is supplied by two renal arteries, the anterior entering at the second and the posterior at the sixth lobe. There is a single renal vein leaving the anterior tip of the organ, and this promptly unites with its fellow to form a common trunk.

The lining of the rectum is smooth. The ileo-cæcal valve is at the 157th gastrostege. The rectal cæcum is 9 mm. long, and is directed forwards and lies on the right side of the ileum. Its walls are thin, and the opening into the cæcum is just anterior and to the right of the valve. Its lumen was filled with faecal matter, though the cæcum and rectum were empty.

Along the dorsal wall of the cloaca there is a longitudinal, rounded ridge, which terminates in a papilla 1 mm. in length, and at the level of the posterior border of the last gastrostege. This ridge is formed by the two parallel tubes of the completely divided vagina; these terminate in two separate orifices at the tip of the papilla. The lining of the vagina is finely and longitudinally plicate. According to Cope\* the vagina in the Peropoda is undivided and the walls are nearly or quite smooth,

\* *Op. cit.* p. 700.

and in the Colubroidea the organ is bilobate and the walls have deep longitudinal grooves. This form more closely resembles the latter.

*CYCLOCORUS LINEATUS* Reinhardt.

*Specimen.* No. 15240. California Acad. Sci. Olongapo, Luzon, P.I. Female; total length 503, tail 81 mm.

*Squamation.*—Scale-rows 17 anteriorly; the V row suppressed at the 127th gastrostege on the right and the 125th on the left, leaving 15 rows which are continuous to the vent. The last scale in the row that is dropped is before an enlarged scale in the row below. Anteriorly an oblique series of scales starting at one gastrostege terminates at the tenth to the rear. Gastrosteges 163. Anal entire. Urosteges 41, single. Præoculars 2, postoculars 2. Anterior temporals 2, posterior 2. Supralabials 8; the third to the fifth entering the eye. Infra-labials 9; the first to the fifth in contact with the anterior genials. Anterior larger than the posterior genials.

*Anatomy.*—The hypapophyses on the dorsal vertebræ are continuous throughout the column. On the vertebra above the 122nd gastrostege the base of the hypapophysis occupies the posterior one-third of the centrum; the apex is horizontally truncate, and extends a trifle posterior to the vertical of its centrum. The caudal vertebra at the level of the 12th urostege has two triangular hæmapophyses the bases of which occupy the posterior half of the centrum. The inferior zygapophyses are developed as broad wing-like plates, 1.4 mm. long.

The maxillary bone at the junction of the anterior and middle third is bent inwards at an angle of 45°, and the teeth are arranged in two groups. The first set consists of 7 teeth that are mounted on the anterior one-third of the bone; the first five are very small and increase in size posteriorly; the sixth is nearly three times the size of the fifth, and the seventh is larger still, being 1.5 mm. long. These teeth are inclined backwards. The two groups are separated by an interval of 1.5 mm. The second set contains 13 teeth; the first nine are small and nearly equal; the tenth to the fourteenth increase rapidly until the last is twice the size of the ninth. These teeth are inclined towards the median line. The anterior tip of the palatine bone reaches the interval between the fifth and sixth maxillary teeth; there are 16 teeth. The pterygoid bone bears 19 teeth; these are on a line that is convex externally; the middle teeth being three times as far from their fellows on the opposite bone as are the teeth at the extremes. The dentary bone is also bent inwards at an angle of 45°, and has the teeth in two groups. The first set is mounted on the inflexed portion of the bone, and consists of 6 teeth; the first to fourth gradually increasing in size; the fifth and sixth strongly enlarged. The two groups are separated by an interval which is shorter than the sixth tooth. The second set consists of 17 very small teeth.

The external landmarks of the principal viscera in terms of gastrosteges are as follows:—

Total number of gastrosteges ...	174	100	p. cent.
Apex of heart .....	37	21·3	
Liver, anterior tip .....	44	25·3	
,, posterior end .....	96	55·1	
Gall-bladder .....	114	65·3	
Kidney, right, anterior tip .....	142	81·8	
,, posterior end ...	149	85·8	
,, left, anterior tip.....	144	82·8	
,, posterior end .....	151	86·8	
Ileo-cæcal valve .....	154	88·5	

The tracheal membrane begins at the glottis, and for a short distance lies along the right side of the tube. Almost immediately it broadens, and at gastrostege 14 it is lined with respiratory tissue. At gastrostege 22 the membrane alters its position so that it forms the dorsal instead of the right wall of the trachea. Well above the apex of the heart the alveoli on the membrane have assumed the same size and shape as those in the lung; there is no gross difference to indicate the ending of one structure and the beginning of the other. The trachea terminates abruptly 7 mm. posteriorly to the apex of the heart. There is no rudimentary lung. Anteriorly the walls of the lung are thick and lined for the entire circumference with pulmonary tissue; posteriorly they become thin and terminate in an air-sac. The lateral lobes of the liver are distinct. The left lobe is the longer; anteriorly it extends beyond the right lobe 6 mm. and posteriorly 11 mm. There are four transverse fissures on the left lobe near the anterior tip, the rest of the organ is smooth. The anterior one-third of the rectum is thickly and regularly plicate; the posterior two-thirds are irregularly folded. There is no body to the vagina. The organ is bilaterally divided into two separate tubes that open into the dorsal wall of the cloaca by two separate orifices, which are 2 mm. apart.

*Notes.*—This species is described as having scales with apical pits, and an eye with a round pupil. Over a dozen specimens have been studied and the pits cannot be made out. The pupil is usually round in the young and frequently vertically oval in the adult.

#### CHRYSOPELEA ORNATA Shaw.

*Specimen.* No. 16707. California Acad. Sci. Cochin China. Female; total length 910, tail 237 mm.

*Squamation.*—The number of scale-rows on the body, the sequence in which they become suppressed, and the gastrostege level at which they terminate on each side may be thus presented:—

17 rows, IV row ends, right 137th, left 136th gastrostege, leaving:  
 15 ,, VIII ,, ,, ,, 137th, ,, 138th ,, ,,  
 13 ,, which are continuous to the vent.

Gastrosteges 227, the last shield divided. Anal entire. Urosteges 120 pairs. Supralabials 10; the fifth to the seventh entering the eye; on the right the fourth is reduced and fused with the posterior inferior angle of the third. Infralabials 10 on the left, 11 on the right, the additional shield is between the corresponding third and fourth. Anterior genials larger than the posterior, the right in contact with four and the left with five infralabials. Gular shields in six pairs.

*Anatomy.*—Maxillary bone with 20 teeth, the posterior three with a broad shallow groove; the five preceding these are also grooved but less distinctly. Palatine bone with 8 teeth, increasing in size posteriorly; the anterior tip of the bone reaches to the interval between the second and third maxillary teeth. Pterygoid bone with 28 teeth. Dentary bone with 18 teeth, the anterior enlarged and grooved on the external quadrant.

In terms of gastrosteges the external landmarks of the viscera are as follows:—

Total number of gastrosteges .....	227	100 p. cent.
Apex of heart .....	58	25·6
Liver, anterior tip .....	73	32·2
"    posterior end .....	112	49·4
Gall-bladder, centre .....	232	58·2
Kidney, right, anterior tip .....	183	80·8
"    "    posterior end .....	201	89
"    left, anterior tip .....	196	86·5
"    "    posterior end .....	214	94·2
Pleo-cæcal valve.....	209	92·2
Vaginal cornua, base .....	216	95

The cartilaginous rings of the trachea are complete from the glottis to the angle of the jaw; from this to their termination on the ventral surface of the lung, at the apex of the heart, they are interrupted. The tracheal membrane begins with the semi-rings; it is on the right side of the tube, and is continued caudad to the base of the heart. For the greater part of its length it comprises more than half the circumference of the tube. At its termination it becomes continuous with the pulmonary pleura. The elasticity of the rings maintains their free ends in close apposition, and the membrane lies in a lax state by the side of the trachea. When the windpipe is dilated, the ends of the rings are separated and the tracheal membrane becomes a functioning part of the organ. Under ordinary conditions the air passes only through that part of the tube that is formed by the semi-rings. Anteriorly the pulmonary tissue begins at the level of the auriculo-ventricular septum. In the lung it is confined strictly to the dorsal half of the circumference. Posteriorly it is drawn out as a fine streak from which are sent out transverse septa; it terminates on the left side of the air-sac, at the level of the 79th ventral. Posteriorly the lung is continued as a membranous air-sac; exactly where it ends cannot be



ascertained. There is a small rudimentary lung, a mere vesicle without pulmonary tissue. The anterior tip of the liver is not divided into lateral lobes; posteriorly the left lobe is about three times as thick as the right, and is 5 mm. longer. The surface is smooth, there being no transverse fissures. The ileo-cæcal valve is at the 209th gastrostege; there is no cut-off tube or rectal-cæcum. The lumen of the rectum is longitudinally plicate, with faint closely-set transverse ridges. The vagina bifurcates at the level of the 216th gastrostege, the walls are smooth.

*Habits.*—The observations made by Mr. Shelford\* on the aerial locomotion that this serpent indulges in afforded one of the most interesting field-notes on a reptile that has been published for some time. Attention was drawn to the hinge-lines along the gastrosteges, and to the habit of retracting the middle section of these shields “so that the snake became deeply concave along the ventral surface”. This serpent has been captured several times in Luzon, and the same performance witnessed. If the lung in this species had thick walls for its entire circumference, this radical change in the shape of the body could not be so readily brought about. On the contrary, it is so modified that when subject to ventral pressure it merely has the lower membranous wall stove in and no serious interference with respiration takes place.

*CROTALUS CONFLUENTUS* Say.

*Specimen.* Field No. 8208. U.S. Nat. Mus. Mt. Tamilpais, alt. 650 M., California. Female; total length 460, tail 45 mm.

*Squamation.*—The number of scale-rows on the body, the sequence in which they become suppressed, and the gastrostege level at which they terminate on each side may be thus presented:—

25 rows,	VI row ends,	right 108th,	left 160th gastrostege,	leaving :
23	” V	”	” 123rd, ” 124th	”
21	” VIII	”	” 165th, ” 162nd	”
20	” X	”	intermittent between 124th and 165th	”
19	”	”	which are continuous to the vent.	”

Ventrals 174. Anal entire. Urosteges 21 entire, the first and last three paired. Præoculars 2, suboculars 2, postoculars 4. Supralabials 14 on the right, 13 on the left side; the reduced count due to the fusion of the fourth and fifth shields.

*Anatomy.*—The external landmarks of the principal viscera in terms of gastrosteges are as follows:—

Total number of gastrosteges	...	174	100 p. cent.
Apex of heart	.....	70	40.2
Liver, anterior tip	.....	70	40.2
” posterior end	.....	109	62.5

\* “A Note on ‘Flying’ Snakes,” P. Z. S. 1906, p. 227.

Kidney, right, anterior tip .....	144	82·8 p. cent.
"    "    posterior end ...	163	
"    left, anterior tip .....	146	84
"    "    posterior end ...	166	
Vagina, apex .....	164	99·2

The cartilaginous rings of the trachea are complete from the glottis to the 6th gastrostegæ. At this point the tracheal membrane begins on the dorsal quadrant of the tube. Almost immediately, while still very narrow, it acquires pulmonary tissue, this rapidly increases and becomes continuous with the lung. The semi-rings extend along the ventral surface of the trachea; viewed from within they appear as a narrow gutter; they terminate 15 mm. caudad from the apex of the heart. The walls of the lung posterior to the heart have a very thin lining of pulmonary tissue; the alveoli are large and shallow in contrast with those in the trachea, which are small, thick, and superimposed. In other words, the area of the respiratory tissue in the lung is much less than it is in the trachea. The liver is deeply divided into a right and left lobe, and these are partially divided by shallow and transverse fissures. Anteriorly the left lobe is thick and rounded, extending three gastrosteges beyond the right, and overlapping the apex of the heart by 1 mm. The peritoneum covering the liver and the abdominal walls is pigmented, the remainder is plain. The vagina is short, it extends over 10 gastrosteges, and is bilobate. The cornua are adherent to each other at the base for a distance of 1·5 mm. Externally each horn gives the appearance of being composed of two adherent tubes, with the oviduct entering the outer. The lining is smooth, and is thrown into several longitudinal folds; two of these are larger than the rest, and their free edges nearly touching tend to divide the lumen of each horn into an inner and an outer compartment.

#### *The Intromittent Organ.*

*Polyodontophis bivittatus* Boulenger.—The hemipenis is undivided and the sulcus simple. The base is plicate and is followed by a spinous zone 4 mm. in length. The spines are about ten in number; there are two placed opposite to the sulcus that are much enlarged, being 2·5 mm. in length. The distal 6·5 mm. of the organ is calyculate. The calyces are very small and their borders bear numerous minute spines. The calyces at the border of the spinous zone and at the tip are enlarged, the latter have simple borders.

In Cope's classification the enlarged basal hooks place this form in the *Natricinæ*. The occurrence of these hooks with a calyculate apex represents a divergence in the direction of the *Colubrinæ*.

*Tropidonotus vibakari* Boie.—The hemipenis and the sulcus spermaticus are undivided. The organ is densely spinous; those on the middle are a trifle the larger, diminishing in size towards

the apex and the base. There are a few enlarged basal hooks situated close to the sulcus, one being on one side and four on the other; of these four the one nearest the base is double the size of any of the others. The tip of the organ is rounded and smooth, and the line of demarcation between the bare and the spinous areas is sharp. On either side of the smooth area at the tip, there are mounted two apical papillæ, which are one-fourth the length of the body of the organ. Each papilla is spinous for three-fourths of its circumference, the inner quadrant being smooth and continuous with the spineless area at the tip.

Terminal papillæ similar to those in this species are of comparatively rare occurrence. Cope has reported them in the genus *Oligodon* Boie, and in the three following species: *Tropidonotus vittatus* Linnæus, *Ischnognathus lineatus* (Hallowell), and *Coluber helenæ* Daudin. Each of these has been set apart by Cope as the type of a new genus, established on the ground that the intermittent organ differed widely from the type prevailing among the nearest allies. *T. vibakari* in this respect is clearly separated from the Far Eastern representatives of the genus. These have been placed in the genus *Bothrodytes* by Cope, and are characterized by having the organ furcate. The organ in *vibakari* most closely resembles that found in *Ischnognathus lineatus* Hallowell, and the figure given by Cope\* of this species shows that it differs from *vibakari* in the one detail of being less completely covered with spines. Furthermore, this serpent is of precisely the same mild-acted and fearless nature that is characteristic of the species of *Ischnognathus*. In this it offers a marked contrast with the Far Eastern members of the genus *Tropidonotus*. Over a dozen species of these have been captured and every one showed a nervous, irritable, and snappy disposition.

To allow this species to remain in a complex genus like *Tropidonotus*, after it has been found to differ so radically, is not good taxonomy. On the other hand, to chronicle promptly each new anatomical discovery under a new generic caption does not materially aid our studies. It is believed that the dilemma can be overcome for the time being by strictly adhering to the nomenclature contained in the 'Catalogue of Snakes in the British Museum,' and at the same time by registering a provisional new generic term. This new term is not to become current until the entire group to which it belongs has been re-examined from the standpoint of comparative anatomy.

With this understanding it is suggested that the new genus *Hebius* be established for *Tropidonotus vibakari* Boie, the salient character distinguishing it from all species of *Tropidonotus* being the densely spinous and undivided hemipenis, bearing two long apical papillæ.

*Helicops angulatus* Linnæus.—The total length of the hemipenis is 42 mm.; it is divided into two quadripenes, the length

\* *Op. cit.* pl. xx. fig. 12.

of each being 10 mm. The quadripenis is calyculate, and the cells are arranged in seven rows that trend obliquely forward from the sulcus. The distal half of the body of the hemipenis is spinous: opposite to the sulcus there is a septal fold. The proximal half is plicate. At the border of the spinous area and close to the sulcus there are two round, flat-topped, and gristle-like papillæ; these are closely set and one is distal to the other. The sulcus is divided at a point 12 mm. from the base, this is well within the plicate area.

Mr. Rosén\* writes that the hypapophyses are absent from the posterior vertebræ in *H. modestus* Günther and *H. leopardinus* Schlegel. In this species they are well developed throughout, one occurring even on the last dorsal vertebra.

*Cyclocorus lineatus* Reinhardt.—The hemipenis is of extreme length and slenderness, being 38 mm. long and 2 mm. in diameter. It is not divided and the sulcus is simple. The base for the distance of 4 mm. is plicate; the remainder of the organ, even to the tip, is spinous. Towards the tip there are three slightly elevated longitudinal ridges, one 8 mm., the others 5 mm. in length. The spines are nearly uniform in size, being about .3 mm. to .4 mm. long. Each is mounted on a broad fleshy base, and is slightly recurved. When the walls are stretched the spines are seen to be arranged in longitudinal series.

*Spilotes pullatus* Linnæus.—The structure in this species is one of the most complicated recorded. The total length of the hemipenis from the base to the insertion of the retractor muscle is 77 mm. The organ and sulcus spermaticus are undivided. From the base to the 20 mm. point are longitudinal plications; the folds are thick, at first straight, later becoming wavy. From the 20 mm. to the 38 mm. point it is densely beset with stout, blunt spines, each of which is about 2.5 mm. long. From the 38 mm. to the 54 mm. point on each side of the sulcus are rows of frounces, these trend obliquely forward and acquire partitions which convert them into rows of calyculi; the cells of these calyculi increase rapidly in size, the largest being situated opposite to the sulcus. On each side of the sulcus at the 60 mm. point are two thick flaps 10 mm. long; these are in the longitudinal plane, hang free in the lumen of the organ, and are covered with small regular ruches. Between one of these flaps and the sulcus there is a thin membranous septum 20 mm. long, parallel to the sulcus, and hanging free in the lumen. Towards the extremity of the organ the calyculi change to irregular frounces; these in turn are converted at the extreme tip into minute frills.

United States Fisheries Steamer 'Albatross',  
Sausalito, California, April 1st, 1913.

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\* Ann. Nat. Hist. (7) xv. 1905, pp. 170-171, fig. 1.